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Project: Virtual Reality Xplorer

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Document Revision History

Revision Number	Revision Date	Description	Rationale
0.1	10/6/13	Initial Integration	
1.0	11/6/13	Before Gate Review	Updated with comments and suggestions from Mr. O'Dell and team Always Home
2.0	11/20/13	Baseline	Updated requirements, acceptance criteria, and use cases according to feedback from the SRS Gate Review

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1. Product Concept

This section describes the purpose, use, and intended user audience for the Virtual Reality Xplorer. The Virtual Reality Xplorer is an educational video game that will employ the Oculus Rift virtual reality device and an Xbox controller to immerse students in a virtual environment where they can learn and explore different topics from their curriculum. Students will be presented different topics and learn how to apply the knowledge they are learning in the virtual sandbox environment. Teachers will be able to see how each student performed in the different virtual environments.

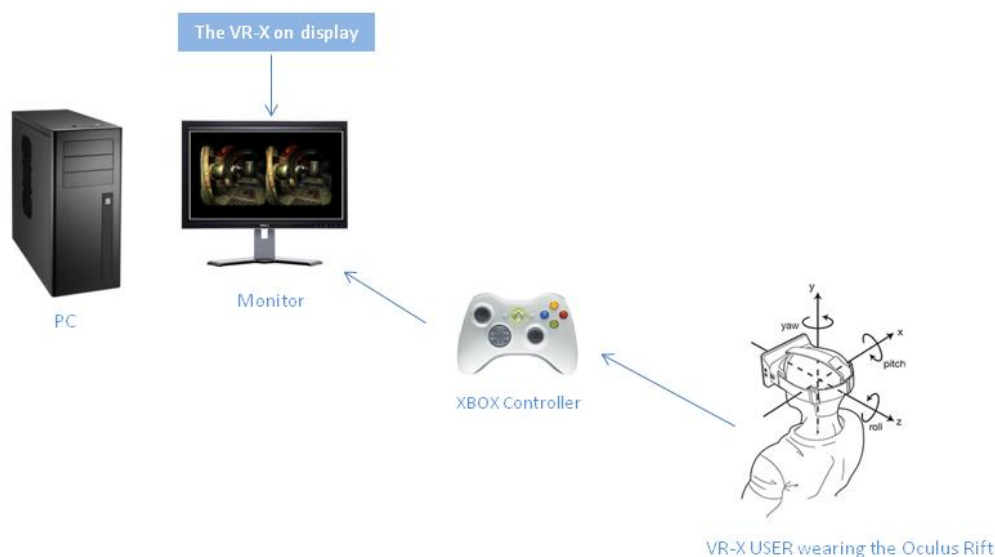
1.1 Purpose and Use

The Virtual Reality Xplorer is a product designed to simulate an environment while simultaneously providing the user an entertaining and educational experience. The Virtual Reality Xplorer will be stored on a PC. The program will be launched from the operating system and display the main menu. Once the user starts a new game, they will be allowed to explore an open environment while the Virtual Reality Xplorer displays information using the heads up display. The user will also encounter intermittent puzzles or challenges.

1.2 Intended Audience

The Virtual Reality Xplorer's intended users will be 5th and 6th grade science students. The intended consumer will be 5th and 6th grade science teachers that want an alternative method of teaching a certain topic. Other audiences may consist of school districts or educational programs.

Figure 1-1 Conceptual Drawing



2. Product Description and Functional Overview

This section provides all the features and functionality associated with the Virtual Reality Xplorer, and a brief description of the product. The Virtual Reality Xplorer is a gaming software intended to run on a computer, in correspondence with the Oculus Rift (A virtual reality hardware Interface), and an Xbox controller.

The software will provide users with an educational, entertaining, and virtual realistic gaming experience, which will include several puzzles, tasks, and interactions with the environment.

2.1 Features and Functions

The Virtual Reality Xplorer is an educational video game. The Virtual Reality Xplorer is modeled as a first-person puzzle solver. The game will consist of multiple stages. Each stage will contain puzzles. The user must solve the puzzles in a stage to gain access to the next stage. Each stage will cover a specific science topic. The user completes the game when all stages are completed.

Users will use the Oculus Rift device and an Xbox controller to control their avatar in the virtual environment. There will be different ways the two devices can be configured to control movement within the virtual environment. The user will be able to select their input configuration from within the game.

The Virtual Reality Xplorer will use an Xbox controller to navigate and interact with objects in the virtual environment. Since the targeted audience is 5th and 6th grade science students, most will already be familiar with how an Xbox controller works. They are more likely to know how to use an Xbox controller to navigate a game rather than a keyboard and mouse.

The Oculus Rift will act as an input and output device. A computer will have the Virtual Reality Xplorer installed and have the Oculus Rift attached. The Oculus Rift will display a duplicate image of the user playing the Virtual Reality Xplorer on the computer. The Oculus Rift is also able to track the user's head movements. As the user moves in real life the scene in the Virtual Reality Xplorer will adjust accordingly.

The Oculus Rift however, will not be able to navigate menus. A controller is required for menu navigation. Also the Oculus Rift will only be able to control the view in the 3-D environment. It will also not be capable of moving the character in the 3-D environment. The Oculus Rift is limited to tracking just head movements and not full body movements.

The Virtual Reality Xplorer will feature a "Load Game" component that allows the user to view and select any saved file and continue from where the player left off. Any player can access any save, even if the save file was started by another player.

Users will be able to explore different virtual environments each one pertaining to a certain topic of the teacher's curriculum. Each virtual environment will have a storyline intended to immerse and entertain the student while providing an educational experience. Each storyline will consist of events that can be triggered by the user navigating to a certain area of the environment, a timer, or the user interacting with an object in the environment. The virtual environments will also include challenges and puzzles that will require the user to apply previously presented information to overcome the challenge or puzzle.

A progress file will be generated for each user. The progress file is intended to give the teacher a summary of the user's performance in the Virtual Reality Xplorer. The information in the progress file will include how many attempts it took a user to solve a puzzle and how long it took them to solve a puzzle.

The user will be able to interact with objects and areas of the environment. Some objects or areas will present information about that object in real life. Other objects may change the environment in some way that directly relates to the curriculum topic of that environment.

The virtual environment may define auto-save points that can be triggered by timer, interacting with an object, completing a challenge or puzzle, or entering a specific area of the environment. The user will be able to load any of the auto-save checkpoints and continue in the environment from that point.

2.2 External Inputs and Outputs

Table 2-1 External Data Flows

Name	Description	Use
Oculus Rift Data	The Oculus Rift will be connected to the PC hosting the Virtual Reality Xplorer	Input: The Oculus Rift will be attached to the user, track head movement, and send the position to the Virtual Reality Xplorer Output: The Oculus Rift will display the Virtual Reality Xplorer to the attached user
Xbox Controller Data	The Xbox Controller will be connected to the PC hosting the Virtual Reality Xplorer wirelessly using a wireless adapter	Input: The Xbox Controller joysticks will navigate the character through the Virtual Reality Xplorer. Input: The Xbox Controller buttons will allow the character to jump, pickup objects, drop objects, push switches, sprint, and progress through coordinated sequences of button presses in the Virtual Reality Xplorer.
Progress File	The Virtual Reality Xplorer will generate a progress report for the user	Output: The Progress File will contain the user's educational progress information to be viewed by the teacher. This will be the time it took the user to complete a task and the amount of times the user attempted a task.

2.3 Product Interfaces

The user will interface with the Virtual Reality Xplorer by introducing the user to a menu allowing him/her to choose from submenus such as New Game, Load Game, Options, and Quit. During user interaction with the environment, the user will be presented with a heads up display (HUD). The HUD will consist of a crosshair to assist in aiming, arrows to mark where to go, and tool tips will pop up when there is opportunity for interaction. The bottom screenshot is purely a mock-up for demonstration purposes and does not reflect the quality of final product.

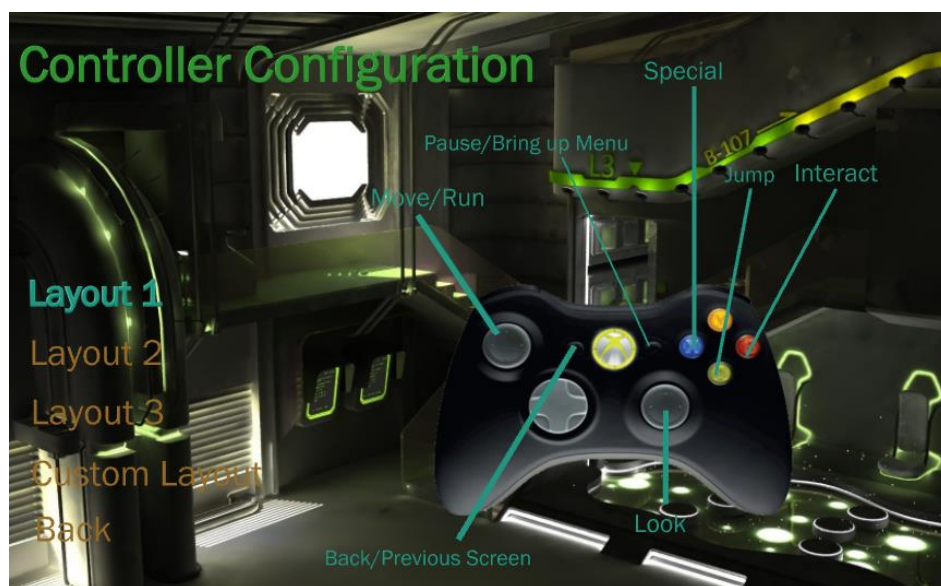
Figure 2-1 Virtual Reality Xplorer Start Screen



Figure 2-2 The Options Screen



Figure 2-3 Controller Configuration/Setup Screen



3. Customer Requirements

This section describes the requirements that are set by team VR-X and the sponsor. The goal for team VR-X is to create an educational video game in a 3D virtual environment. These requirements describe what the students will experience when they use the Virtual Reality Xplorer. They also describe what functions Virtual Reality Xplorer will provide to teachers.

3.1 The student will learn about matter

3.1.1 Description: The student will learn about states of matter, properties of matter, boiling and freezing points of water, and mixtures by solving puzzles based on these topics.

3.1.2 Source: Sponsor Lorri Newsom

3.1.3 Constraints: None

3.1.4 Standards: Texas Essential Knowledge and Skills

3.1.5 Priority: 1 – Critical

3.2 The student will learn about force, motion, and energy

3.2.1 Description: The student will learn about the uses of energy, electrical circuits and how they produce energy, and the effect of force on an object by solving puzzles based on these topics.

3.2.2 Source: Sponsor Lorri Newsom

3.2.3 Constraints: None

3.2.4 Standards: Texas Essential Knowledge and Skills

3.2.5 Priority: 1 – Critical

3.3 The student will learn about organisms and environments

3.3.1 Description: The student will learn about the way organisms live and survive, food chains, ecosystem changes, carbon dioxide-oxygen cycle, adaptations, inherited traits and learned behaviors by solving puzzles based on these topics.

3.3.2 Source: Sponsor Lorri Newsom

3.3.3 Constraints: None

3.3.4 Standards: Texas Essential Knowledge and Skills

3.3.5 Priority: 1 – Critical

3.4 The student will learn about light reflection and refraction

3.4.1 Description: The student will learn about light traveling in a straight line, light reflection off of objects, and refraction of objects by solving puzzles based on these topics.

3.4.2 Source: Sponsor Lorri Newsom

3.4.3 Constraints: None

3.4.4 Standards: Texas Essential Knowledge and Skills

3.4.5 Priority: 1 – Critical

3.5 Generate progress file

3.5.1 Description: A teacher must be able to track the progress of his or her students and identify problem areas for each student. The information in the progress file will include how many attempts it took a user to solve a puzzle and how long it took them to solve a puzzle.

3.5.2 Source: Sponsor Lorri Newsom

3.5.3 Constraints: None

3.5.4 Standards: None

3.5.5 Priority: 1 – Critical

3.6 Entertaining

3.6.1 Description: The application must entertain and capture the students' attention. The game should have an immersive story and inspire the students to explore the virtual environment.

3.6.2 Source: Sponsor Lorri Newsom

3.6.3 Constraints: The application must be appropriate for 5th and 6th grade students.

3.6.4 Standards: None

3.6.5 Priority: 1 – Critical

3.7 Interactive

3.7.1 Description: The application must be interactive and allow the students to have some control over the virtual environment and allow them to create their own educational experience.

3.7.2 Source: Sponsor Lorri Newsom

3.7.3 Constraints: The application must still remain educational and limit the students from spending too much time on things that do not provide real educational value.

3.7.4 Standards: None

3.7.5 Priority: 1 – Critical

3.8 Semantically Realistic

3.8.1 Description: The virtual environment must provide some semblance of realism. Interactions must be as realistic as is reasonable.

3.8.2 Source: Sponsor Lorri Newsom

3.8.3 Constraints: The Virtual Reality Xplorer remain educational and fun. The application cannot be truly 100% realistic.

3.8.4 Standards: None

3.8.5 Priority: 3 – Moderate

3.9 User must be able to configure controls

3.9.1 Description: The user must have the option to setup how the input devices (Oculus Rift and Xbox controller) control the user's character in the game.

3.9.2 Source: Team VR-X

3.9.3 Constraints: Oculus Rift and Xbox controller input devices

3.9.4 Standards: None

3.9.5 Priority: 1 – Critical

4. Packaging Requirements

The package will include the physical headwear needed to experience virtual reality, the game software, a controller, and a user manual.

4.1 Oculus Rift

4.1.1 Description: The system must be packaged with an Oculus Rift itself.

4.1.2 Source: Team VR-X

4.1.3 Constraints: None

4.1.4 Standards: None

4.1.5 Priority: 1 – Critical

4.2 User Manual

4.2.1 Description: The system must be provided with a CD that will contain the manual for how the system operates. The user manual must include instructions for setting up the Oculus Rift device and Xbox controller on the host system.

4.2.2 Source: Team VR-X

4.2.3 Constraints: A format that is accessible such as pdf or word document.

4.2.4 Standards: None

4.2.5 Priority: 2 – High

4.3 Game Software

4.3.1 Description: The executable file including the audio, video, graphics, maps, and code will be provided on a CD.

4.3.2 Source: Team VR-X

4.3.3 Constraints: Software cannot exceed CD storage capacity

4.3.4 Standards: Windows 7 compatibility

4.3.5 Priority: 1 – Critical

4.4 Game Controller

4.4.1 Description: The game controller must be a standard Xbox 360 controller.

4.4.2 Source: Team VR-X

4.4.3 Constraints: Installing drivers necessary for the controller to work

4.4.4 Standards: None

4.4.5 Priority: 1 – Critical

5. Performance Requirements

This section lists the performance requirements for the product Virtual Reality Xplorer. These requirements include frame rate, graphics quality, and installation.

5.1 Frame Rate

5.1.1 Description: The Virtual Reality Xplorer provides smooth gameplay and animations as to not disrupt the user's immersion.

5.1.2 Source: Team VR-X

5.1.3 Constraints: Limited by the PC's video card

5.1.4 Standards: Standard frame rate is 60vFPS being ideal and 25 FPS being absolute bare minimum

5.1.5 Priority: 2 – High

5.2 Graphics Quality

5.2.1 Description: The Virtual Reality Xplorer must feature software that will contain high resolution textures.

5.2.2 Source: Team VR-X

5.2.3 Constraints: None

5.2.4 Standards: Ideally 1280 x 720 resolution and higher but 640 x 480 is the bare minimum

5.2.5 Priority: 2 – High

5.3 Installation

5.3.1 Description: The Xplorer must feature user friendly installation of the hardware as well as the software.

5.3.2 Source: Team VR-X

5.3.3 Constraints: Hardware configuration of the user's PC.

5.3.4 Standards: None.

5.3.5 Priority: 1 – Critical

5.4 Responsiveness

5.4.1 Description: The Xplorer must implement proper responsive checks so as to not disorient the user too quickly. Ideal response time is 1/60 seconds.

5.4.2 Source: Team VR-X.

5.4.3 Constraints: Biological feedback from the user.

5.4.4 Standards: None.

5.4.5 Priority: 1 – Critical

6. Safety Requirements

This section describes the safety concerns raised by using the Oculus Rift device in a 3D virtual environment. The effects of the Oculus Rift device and how to keep the device's hardware from interfering with the experience are addressed. Any possible side effects of visual stimuli projected directly in front of a person's eyes are addressed as well.

6.1 Nausea Caused by Oculus Rift

6.1.1 Description: The application must attempt to minimize the chance of users becoming nauseous. Either by limiting the amount of time required to complete levels or by manipulating graphical output to the Oculus Rift device.

6.1.2 Source: Team VR-X

6.1.3 Constraints: None

6.1.4 Standards: None

6.1.5 Priority: 2 – High

6.2 Precautions for Epileptic Users

6.2.1 Description: The application must not use visuals that could trigger a seizure in an epileptic user.

6.2.2 Source: Team VR-X

6.2.3 Constraints: None

6.2.4 Standards: None

6.2.5 Priority: 1 – Critical

6.3 Space Constraints

6.3.1 Description: The application must take into account the space constraints that may be present in a classroom environment. The configuration of the Oculus Rift and controller device should be so that the user can remain in one orientation while moving about the virtual environment.

6.3.2 Source: Team VR-X

6.3.3 Constraints: None

6.3.4 Standards: None

6.3.5 Priority: 3 – Moderate

6.4 Oculus Rift Cable Constraints

6.4.1 Description: The configuration of the Oculus Rift must be so that the user is not hindered by the cord that connects the device to the computer.

6.4.2 Source: Team VR-X

6.4.3 Constraints: None

6.4.4 Standards: None

6.4.5 Priority: 3 – Moderate

7. Maintenance and Support Requirements

This section covers the requirements related to the maintenance and support of the Virtual Reality Xplorer.

7.1 Code Documentation

7.1.1 Description: The code must be heavily documented with appropriate comments. Some activity diagrams such as flow charts will be included to depict the flow of the program execution and functionality. The code will also be written in a systematic way to enhance readability and to avoid spaghetti code.

7.1.2 Source: Team VR-X

7.1.3 Constraints: None

7.1.4 Standards: None

7.1.5 Priority: 2 – High

7.2 Testing and Troubleshooting

7.2.1 Description: The code must be written in a way to address troubleshooting incidents that could occur.

7.2.2 Source: Team VR-X

7.2.3 Constraints: None

7.2.4 Standards: None

7.2.5 Priority: 1 – Critical

8. Other Requirements

This section describes extra requirements for the Virtual Reality Xplorer to be complete that are not previously listed. These are miscellaneous requirements that current video games adhere to such as the ability to play on different platforms, having minimum hardware and software requirements, and having a well-designed user interface.

8.1 Cross-Platform Compatibility

8.1.1 Description: The Virtual Reality Xplorer must work with Windows and Mac OS.

8.1.2 Source: Team VR-X

8.1.3 Constraints: Team VR-X lacks knowledge in developing for Mac OS.

8.1.4 Standards: None

8.1.5 Priority: 5 – Future

8.2 Support Minimum Hardware and Software Requirements

8.2.1 Description: The machines running the Virtual Reality Xplorer must meet minimum hardware and software requirements to support the Oculus Rift device and the Virtual Reality Xplorer. Minimum requirements are as follows:

Platform: Windows XP SP3 or Windows Vista

Processor: 2.0 GHz processor

RAM: 2 GB

SM3-compatible video card

HDD: 3 GB Hard Drive Space

8.2.2 Source: Team VR-X

8.2.3 Constraints: Hardware components may exceed the project budget.

8.2.4 Standards: None

8.2.5 Priority: 2 – High

8.3 Portability

8.3.1 Description: The Virtual Reality Xplorer must be able to be installed on different machines with different hardware configurations.

8.3.2 Source: Team VR-X

8.3.3 Constraints: The machines must still support the minimum hardware and software requirements.

8.3.4 Standards: None

8.3.5 Priority: 3 – Moderate

8.4 American English Standard

8.4.1 Description: The Virtual Reality Xplorer must use the American English language as the default for any voice overs and text.

8.4.2 Source: Team VR-X

8.4.3 Constraints: None

8.4.4 Standards: None

8.4.5 Priority: 1 – Critical

8.5 User Friendly User Interface

8.5.1 Description: The Virtual Reality Xplorer must have an intuitive and easy to use user interface.

8.5.2 Source: Team VR-X

8.5.3 Constraints: None

8.5.4 Standards: None

8.5.5 Priority: 2 – High

8.6 Multiplayer

8.6.1 Description: The Virtual Reality Xplorer must allow multiple users to interact in the same environment in real-time.

8.6.2 Source: Team VR-X

8.6.3 Constraint: Networking falls outside of the project scope due to time.

8.6.4 Standards: None

8.6.5 Priority: 5 – Future

8.7 Omni Treadmill Integration

8.7.1 Description: Team VR-X must integrate the Virtual Reality Xplorer to utilize the Omni Virtuix Treadmill as an input device.

8.7.2 Source: Team VR-X

8.7.3 Constraint: The Omni Virtuix Treadmill won't be released until 2014 and the cost exceeds our budget.

8.7.4 Standards: None

8.7.5 Priority: 5 – Future

8.8 Offered on Game Client

8.8.1 Description: The Virtual Reality Xplorer must be offered on a PC game client such as Steam or Origin.

8.8.2 Source: Team VR-X

8.8.3 Constraint: Criteria from game clients to add games to their libraries

8.8.4 Standards: None

8.8.5 Priority: 5 – Future

8.9 Online Patching

8.9.1 Description: Bug fixes and patches must be delivered through an online update mechanism.

8.9.2 Source: Team VR-X

8.9.3 Constraint: None

8.9.4 Standards: None

8.9.5 Priority: 5 – Future

8.10 Downloadable Content

8.10.1 Description: The user must be able to download additional content such as additional environments online.

8.10.2 Source: Team VR-X

8.10.3 Constraint: None

8.10.4 Standards: None

8.10.5 Priority: 5 – Future

9. Acceptance Criteria

This section will discuss the criteria required for the Virtual Reality Xplorer to be accepted as a completed project. These are requirements that Team VR-X and the sponsor have discovered to determine the product is successful.

9.1 Verify that the Virtual Reality Xplorer uses Virtual Reality

9.1.1 Requirement(s) addressed:

Table 9-1 Virtual Reality Verification

Number	Requirement
3.4	Interactive
3.5	Semantically Realistic
4.1	Oculus Rift

9.1.2 Verification Procedure: The Virtual Reality Xplorer will be tested to ensure that the user feels that they are in a virtual environment. The use of the Oculus Rift does not ultimately verify that the product is Virtual Reality. The user must also be able to interact with objects in the virtual environment.

9.2 Verify that the Virtual Reality Xplorer is Educational

9.2.1 Requirement(s) addressed:

Table 9-2 Educational Verification

Number	Requirement
3.1	The student will learn about matter

3.2	The student will learn about force, motion, and energy
3.3	The student will learn about organisms and environments
3.4	The student will learn about light reflection and refraction
3.5	Ability to track student progress

9.2.2 Verification Procedure: The Virtual Reality Xplorer will be tested by the sponsor to ensure it presents the information listed in the TEKS in an educational manner. The sponsor will also verify that the student progress reports have meaningful information.

9.3 Verify that the Virtual Reality Xplorer is Entertaining

9.3.1 Requirement(s) addressed:

Table 9-3 Entertaining Verification

Number	Requirement
3.6	Entertaining
3.7	Interactive

9.3.2 Verification Procedure: Team VR-X will test Virtual Reality Xplorer with the sponsor's class to evaluate how the students respond to the game.

9.4 Verify Fidelity (degree to which something matches or copies something else)

9.4.1 Requirement(s) addressed:

Table 9-4 Fidelity Verification

Number	Requirement
3.5	Semantically Realistic
5.2	Graphics Quality

9.4.2 Verification Procedure: The Virtual Reality Xplorer will be tested by multiple users to ensure that the user can make associations from virtual objects to real life objects. The users will also inspect the quality of the graphics, ensuring that it is high enough to make associations.

9.5 Verify the Virtual Reality Xplorer is Safe

9.5.1 Requirement(s) addressed:

Table 9-5 Safety Verification

Number	Requirement
6.1	Nausea Caused by Oculus Rift
6.2	Precautions for Epileptic Users
6.3	Space Constraints
6.4	Oculus Rift Cable Constraints

9.5.2 Verification Procedure: The Virtual Reality Xplorer will be tested by multiple users to ensure that the user is safe. The users will be monitored while using the Virtual Reality Xplorer ensuring the user does not get sick. The users will also be monitored to ensure they do not bump into real life objects or get tangled in the Oculus Rift cable.

9.6 Verify the Virtual Reality Xplorer is User Friendly

9.6.1 Requirement(s) addressed:

Table 9-6 User Friendliness Verification

Number	Requirement
3.4	Interactive
3.6	User must be able to configure controls

9.6.2 Verification Procedure: The Virtual Reality Xplorer will be tested by multiple users to ensure that the Virtual Reality Xplorer is user friendly. The users must be allowed to interact with the environment using controls that make the most sense to them. The user will also be monitored to ensure that all menus make sense and are intuitive and easy to use.

10. Use Cases

This section provides the use cases that the Virtual Reality Xplorer will undergo and depicts the following relationship: The “User to System interaction” (High-Level use cases). The user shall start the process by starting the program. The user shall have the option to configure controls. If the program has never been used before, the user shall start a new game. If the program has been used earlier, the user shall have the option to either start a new game or load a previous game. The user shall also have the option to save a game during game play. The game will also be auto saved after every milestone task is completed. During game play, the user shall have the option of quitting, configuring controls, or saving the game. After game play, the user shall be provided the option to exit the program, start a new game, or load a previous game.

10.1 Start Program

10.1.1 Scenario: The user starts the program by clicking/opening the Virtual Reality Xplorer Icon. The program will load and the main menu will be displayed.

10.1.2 Actor(s): Virtual Reality Xplorer users

10.1.3 TUCBW: The user clicks the VR-X logo.

10.1.4 TUCEW: The user sees the game menu.

10.2 Configure User Control

10.2.1 Scenario: The user clicks the “Set Configuration” button. A page containing the default configuration is displayed for changes.

10.2.2 Actor(s): Virtual Reality Xplorer users

10.2.3 TUCBW: The user clicks the “Set Configuration” button.

10.2.4 TUCEW: The user sees their chosen configuration.

10.3 Start New Game

10.3.1 Scenario: The user clicks the “New game” button. A new game will be loaded.

10.3.2 Actor(s): Virtual Reality Xplorer users

10.3.3 TUCBW: The user clicks the “New game” button.

10.3.4 TUCEW: The user sees a new game play.

10.4 Save Game

10.4.1 Scenario: The user saves a game during game play by clicking the home key on the keyboard or controller. This will make the game pause and a sub-menu to Save, Set Configuration, and Quit will be displayed. The user shall choose whether to save by clicking the “Save” button, or proceed with the game play without saving. If the user chooses to save the game, an option will be provided for the user to enter their name. The system will save the game and display the name, date, time and level were the game was saved. The game will also be auto saved after every milestone task is completed.

10.4.2 Actor(s): Virtual Reality Xplorer users

10.4.3 TUCBW: The user clicks the Home key and “Save” button.

10.4.4 TUCEW: The user sees their provided name, date, time, and level the game was saved.

10.5 Quit Game

10.5.1 Scenario: The user quits a game during game play by clicking the home key on the keyboard or controller. This will make the game pause and a sub-menu with the option to Quit, Save, Set Configuration will be displayed. The user shall choose whether to quit a game by clicking the “Quit” button, or proceed with the game play without quitting. If the user chooses to quit the game, a warning message will be displayed prompting the user to verify if they want to quit the game. If the user quits the game, the program redirects the user to the main menu.

10.5.2 Actor(s): Virtual Reality Xplorer users

10.5.3 TUCBW: The user clicks the Home key and “Quit” button.

10.5.4 TUCEW: The user sees the main menu.

10.6 Load Game

10.6.1 Scenario: The user clicks the “Load game” button. The program displays a list of all the saved games. The user selects the game they wish to be loaded, and the game is loaded. If there are no saved games the user will see an empty list.

10.6.2 Actor(s): Virtual Reality Xplorer users

10.6.3 TUCBW: The user clicks the “Load game” button.

10.6.4 TUCEW: The user sees the loaded game play.

10.7 Interact with Objects

10.7.1 Scenario: The user approaches an interactive object. A popup command is displayed, the user performs the command, and the object performs an action. The user sees the action.

10.7.2 Actor(s): Virtual Reality Xplorer users

10.7.3 TUCBW: The user approaches an interactive object.

10.7.4 TUCEW: The user sees the action.

10.8 Exit Program

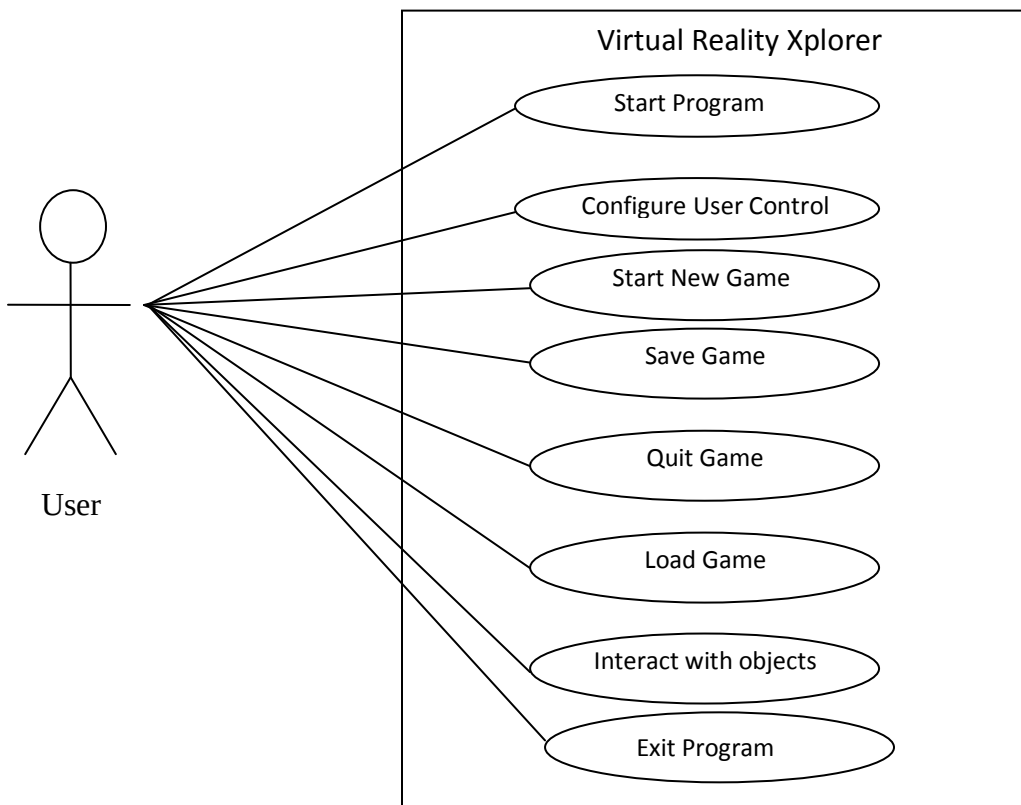
10.8.1 Scenario: The user exits the program by clicking the “Exit Program” button. The program will be closed, and the user will be returned back to their home screen.

10.8.2 Actor(s): Virtual Reality Xplorer users

10.8.3 TUCBW: The user clicks the “Exit Program” button.

10.8.4 TUCEW: The user is returned back to their home screen.

Figure 10-1 Virtual Reality Xplorer Key Operations



11. Feasibility Assessment

This section titled “Feasibility Assessment” analyzes the probability of success in regards to fulfilling the requirements for the Virtual Reality Xplorer. This section includes scope analysis, research, technical analysis, cost analysis, resource analysis, and schedule analysis.

11.1 Scope Analysis

Due to Team VR-X’s technical skills and experience, most critical requirements (priority 1 and 2) will be feasible to prototype by the deadline date. These will require a lot of determination to learn new material quickly which Team VR-X is willing to sacrifice. High priority requirements such as: (3.1) Matter, (3.2) Force, Motion, Energy (3.3) Organisms and Environment, (3.4) Light, Reflection, Refraction will be feasible to implement due to the assistance of the sponsor and the use of the Texas Essential Knowledge and Skills curriculum. The sponsor will also guide and provide team VR-X with any required resources to evaluate our progress in meeting the mentioned requirements such as textbooks and teacher’s feedback. Another high priority requirement that will be possible to implement is (3.6) Entertaining. Team VR-X will not have a problem implementing this task because of our creativity and passion for game entertainment. Team VR-X will not rely solely on our passion for games, so the use of popular children’s games and shows such as the Magic School Bus as reference material will enable the team to create quality entertainment for children.

Other requirements that might be feasible to implement but could also still be a problem are: (3.7) Interactive. First of all, most members of Team VR-X have little experience in graphics or game programming, so making the game interactive and virtually realistic within the given time period will require most of the teams’ effort. Team VR-X intends to use online game development tutorials conducted by industry professionals as a guide to master the necessary skills needed to complete requirementsrequirementsrequirements (3.7) in a short period of time. Most team members are willing to work during the break to make sure that the task is completed in a timely fashion. Modeling a virtual environment also requires adequate 3-D artistic skills which are beyond the scope of the team’s technical skills. Although Team VR-X will use online tutorials to reduce the difficulty of this task, the team also intends to utilize already-developed characters and environment from the game engines’ libraries.

Requirement (8.2) Minimum Hardware and Software requirement might be difficult to accomplish in a timely schedule. This requirement requires the Virtual Reality Xplorer software to work with Oculus Rift hardware, which is still scarce in the consumer market. This will definitely cost the team time to finish the product within the given deadline. Drastic measures have been taken by Team VR-X to avoid this predicament, which is the early purchase of the Oculus Rift. With an early possession of the Oculus Rift device, Team VR-X will be able to resolve any compatibility issues with the Virtual Reality Xplorer software and the Oculus Rift hardware. Any more technical difficulties that could be encountered during

the production of the Virtual Reality Xplorer software will be resolved through the assistance of the Oculus Rift developers' community.

11.2 Research

This section of the document covers the topics that Team VR-X must research to help determine the practicality and feasibility of the product. This section covers the research that has already been done and the research that still needs to be done as of the writing of this section.

The research that has been completed is as follows:

- The Oculus Rift device has already been ordered and there are plenty of games that have been developed with Oculus Rift support. There exist multiple game development engines that also support the Oculus Rift. Thus, it seems feasible that this project can be developed to work with the Oculus Rift device.
- Various tools will be required to create 3D models, textures, and audio resources for the Virtual Reality Xplorer game. There exist free and commercially available software tools for each of these things and they are fairly trivial to obtain. The availability of such tools leads us to conclude that it will be feasible to create the required resources for Virtual Reality Xplorer.

There is still much research that remains to be done:

- VR-X is different from other Senior Design projects in that it is a video game and the development effort is mostly software oriented. The life cycle of a video game software application can be significantly different than a business or systems application. The field of video game development is also different in that it is generally seen as less structured than other software development. Team VR-X must research what methodologies apply best to the product that is being developed.
- Research must be done to discover what it means to create an educational video game. Existing educational video games and development methodologies for educational software need to be explored and evaluated.
- Using an Xbox controller as an input device requires that the team research if there exist an APIs for interfacing with the controller and how well that API will integrate into the development of VR-X.
- An application such as VR-X requires 3D modeling and texturing. Research needs to be done as to how to best approach these tasks and which software tools are best suited for each type of work.
- Creating the mechanics of user interaction with the virtual environment will also require team VR-X to research best practices for maximum user-friendliness. The goal is to have controls that

are easy to learn and intuitive. Games that already have Oculus Rift support would be a good starting point for this research.

- Research game engines and how environments are created, stored, and loaded by the game engine that the product will be built on top of.
- Research will have to be done to explore the best practices for the software architecture that corresponds to the game engine that will be chosen by Team VR-X.
- The Oculus Rift is known to cause some motion sickness, dizziness, and nausea. Research must be done to determine how to minimize those effects on young children.
- Team VR-X will also have to research how to create, store, and load audio resources that will be used throughout the Virtual Reality Xplorer game.

11.3 Technical Analysis

Incorporating the Oculus Rift and an Xbox controller as the input and output devices for the Virtual Reality Xplorer will be feasible according to the research about the Oculus Rift device. There is evidence that other games have been implemented to use an Xbox controller as an input device for PC games. Team VR-X possesses the programming skills required to learn and make use of the APIs for both devices. The game development industry makes it evident that developing a product such as the Virtual Reality Xplorer is entirely feasible seeing as very similar products have been successfully developed.

The tools required for the development of the Virtual Reality Xplorer will require that each team member take the time to learn how to use them. One game engine that has been discussed is the Unreal Engine. It allows users to program either in C++ or C#. Other tools required include a 3D modeling application. Two applications have been considered: Blender (free, open-source) and Mesa3D (not free). Both applications have their pros and cons but research must still be done to determine which one will best suit the needs for Team VR-X. The idea of using 3D stereo audio to create a more immersive experience has been considered. It is likely, however, that the team lacks the equipment and expertise to create such audio and it may not be feasible to attempt to produce such audio. More research is still required.

11.4 Cost Analysis

Team VR-X is allotted 800 dollars in order to successfully complete the project. The most important component, the Oculus Rift will cost 300 dollars (shipping and tax not included). A wireless headset is needed for consumer need and will cost around 60 to 90 dollars. This project will most likely need software that usually runs around 100 dollars. An Xbox 360 Wireless Controller with PC compatibility will be provided by Team VR-X and will cost 45 to 50 dollars. CDs needed to store the software are roughly 1 dollar. This comes to a total of 540 dollars maximum. This amount gives Team VR-X

leniency in choosing particular software needed to create the Virtual Reality Xplorer if one software option is insufficient.

11.5 Resource Analysis

Team VR-X consists of two software engineers, one computer engineer, and one computer scientist. All members are well qualified programmers, and have a firm background in C- style languages. This skill will be beneficial because most of the game engines needed to develop for the Oculus Rift support C# and C++. JavaScript is another programming language needed to support scripting on most gaming platforms, and all VR-X team members possess strong knowledge in this language. Joseph Onwuchekwa, one of the software engineers from Team VR-X is a skilled artist currently practicing to better his craft. He would serve as the team's character design or environment design specialist.

Other team members such as Osuvaldo Ramos, Chris Otterbine, and Sukuya Nakhaima may not possess tremendous artistic skills, but they do possess artistic creativity and imagination which is essential in creating an imaginative environment. All team members are passionate gamers who understand key requirements for gaming systems from its sceneries to its game play design. All Team VR-X members have some kind of experience in 2D game programming, which might not be enough experience to implement a 3D gaming software but, never the less, it could serve as starting point.

Team VR-X comprises of industry experienced individual who are skillful in multiple aspect of software development. Chris Otterbine has worked in the industry as a software tester. He was responsible for aiding the company conduct unit testing, which will be needed to ensure high performance by the VR-X. Osuvaldo Ramos is a well experienced software developer, who is responsible for the team's overall performance. He is a talented programmer with adequate management skills. He has led previous successful team projects at UTA and is also a profound researcher and debugger. Sukuya Nakhaima is the team's hardware lead because of his experience with hardware in the Computer Engineering discipline here at UTA. He is skilled in researching the relative hardware components needed for the project. Although all team members have the appropriate skills needed to implement the project, more training is required for all team members in order to be experts in such necessary fields like 3D modeling, 3D rendering and animation, video game architecture and audio processing.

11.6 Schedule Analysis

To estimate the schedule of the Virtual Reality Xplorer Jones First Order Estimation is used to estimate size in function points. The Unadjusted Function Point total is used in conjunction with COCOMO II to estimate a schedule and the Adjusted Function Point total is used with Jones First Order Estimation Practice to estimate another schedule. The function points used are a very rough estimate taking into account a very preliminary virtual solar system exploration environment. This schedule analysis is subject to change in the near future after meeting with the team's teacher sponsor.

11.6.1 Jones First Order Estimation with Function Points

Table 11-1 Influence Factors

General System Characteristic	Influence (0 – 5)
Data Communications	1
Distributed Data Processing	0
Performance	5
Heavily Used Configuration	3
Transaction Rate	0
On-Line Data Entry	0
End-User Efficiency	5
On-Line Update	0
Complex Processing	4
Reusability	2
Installation Ease	2
Operational Ease	1
Multiple Sites	0
Facilitate Change	3
Total	26
Influence Factor	0.91

Table 11-2 Function Points and Adjusted Function Points

	Low Complexity	Medium Complexity	High Complexity	Total
Number of Inputs	4 x 3	2 x 4	0 x 6	20
Number of Outputs	0 x 4	0 x 5	1 x 7	7
Inquiries	24 x 3	6 x 4	0 x 6	96
Logical Internal Files	0 x 7	1 x 10	0 x 15	10
External Interface Files	0 x 5	0 x 7	1 x 10	10
Unadjusted Function Points				143
Adjusted Function Points (Influence Factor * Unadjusted Function Points)				130

The function point analysis is done with the following assumptions. There will be four input screens: the main menu, pause menu, options menu, and controller configuration. Each level of the game consists of an average of 6 low complexity inquiries, and 1.5 medium complexity inquiries. The output to the Oculus Rift device is considered 1 high complexity output and the input from the device as 1 medium complexity input. The Xbox controller input is also 1 medium complexity input. The progress file that is output by the program is considered 1 logical internal file. These function points correlate to the requirements that team VR-X has prioritized as critical.

Table 11-3 Estimated Schedules

	Best Case	Average Case	Worst Case
Power	0.39	0.42	.45
Estimated Schedule (Calendar Months)	$130^{0.39} = 6.67$	$130^{0.42} = 7.72$	$130^{0.45} = 8.94$

Assuming team VR-X has average performance the project is feasible in the time span of the two semesters of Senior Design I and II. In the best case scenario, team VR-X would have time to implement lower priority requirements and include enhancements to the quality of the product such as optimizations and graphics quality. In a worst-case scenario team VR-X would reanalyze the critical requirements and only implement the levels and requirements that are feasible in the time remaining.

11.6.2 COCOMO II Estimation

The USC COCOMO II Web tool (found at <http://csse.usc.edu/tools/COCOMOII.php>) was used to calculate a schedule estimate based on the Unadjusted Function Points calculated in the previous section. Two sets of parameters were used to calculate a range between worst-case and best-case scenarios.

The following parameters were used to estimate a best-case scenario:

Figure 11-1 Best-Case Parameters for COCOMO II Estimate

Software Size		Sizing Method Function Points	
Unadjusted Function Points	204	Language	3rd Generation Language
Software Scale Drivers			
Precedentedness	High	Architecture / Risk Resolution	Nominal
Development Flexibility	High	Team Cohesion	Very High
Software Cost Drivers			
Product		Personnel	Platform
Required Software Reliability	Low	Analyst Capability	High
Data Base Size	Low	Programmer Capability	High
Product Complexity	Nominal	Personnel Continuity	Very High
Developed for Reusability	Nominal	Application Experience	Nominal
Documentation Match to Lifecycle Needs	Very Low	Platform Experience	Nominal
		Language and Toolset Experience	Nominal
			Project
			Use of Software Tools
			Nominal
			Multisite Development
			Very Low
			Required Development Schedule
			Very Low

The software scale drivers describe areas of development that are not in direct control by team VR-X. Video game development is a highly precedented field. The only new technology team VR-X will use is the Oculus Rift device which is proven to work well with modern game engines thus it does not affect the precedentedness of the project significantly. Likewise the process maturity of video game development has matured and team VR-X can glean from the lessons learned of past developers. The factors in software cost drivers were derived from assumptions made about the product, team VR-X and the platform the product is developed on. Team VR-X expects to have full personnel continuity because each team member is expected to remain enrolled in Senior Design I and II. The team has capable programmers that can learn the necessary APIs and learn to apply them accordingly. These best-case parameters resulted in an effort estimation of 7.1 months.

Figure 11-2 Worst-Case Parameters for COCOMO II Estimate

Software Size		Sizing Method Function Points	
Unadjusted Function Points	204	Language	3rd Generation Language
Software Scale Drivers			
Precedentedness	High	Architecture / Risk Resolution	Nominal
Development Flexibility	High	Team Cohesion	Very High
Software Cost Drivers			
Product		Personnel	Platform
Required Software Reliability	Low	Analyst Capability	Nominal
Data Base Size	Low	Programmer Capability	Nominal
Product Complexity	Nominal	Personnel Continuity	Very High
Developed for Reusability	Nominal	Application Experience	Nominal
Documentation Match to Lifecycle Needs	Very Low	Platform Experience	Low
		Language and Toolset Experience	Low
			Project
			Use of Software Tools
			High
			Multisite Development
			Very Low
			Required Development Schedule
			Very Low

The worst-case parameters mainly focused on reducing the personnel capabilities and attempted to more accurately model the difficulties team VR-X will experience in working with unfamiliar tools and programming environments. These parameters also take into account the increased effort of learning to use new tools to develop a video game more-so than the previous parameters. This calculation resulted in a worst-case estimation of 8.0 months.

Both estimations give similar results and reinforce the feasibility of completing the critical requirements of the Virtual Reality Xplorer.

12. Future Items

This section describes functions for the Virtual Reality Xplorer. These are items that cannot be done during implementation because of constraints due to time, feasibility, complexity, and technology. These future items are modeled after items that video games in industry support after a release. Future items include online support, future technology support, and support for additional content.

12.1 Online Patching

12.1.1 Description: Bug fixes and patches must be delivered through an online update mechanism.

12.1.2 Source: Team VR-X

12.1.3 Constraint: None

12.1.4 Standards: None

12.1.5 Priority: 5 – Future

12.2 Multiple Environments

12.2.1 Description: The Virtual Reality Xplorer must have multiple environments or stages from which to select.

12.2.2 Source: Team VR-X

12.2.3 Constraint: Due to time and lack of design skills we will not be able to implement this requirement.

12.2.4 Standards: None

12.2.5 Priority: 5 – Future

12.3 Downloadable Content

12.3.1 Description: The user must be able to download additional content such as additional environments online.

12.3.2 Source: Team VR-X

12.3.3 Constraint: Online or internet support for Virtual Reality Xplorer falls outside of the project scope due to time.

12.3.4 Standards: None

12.3.5 Priority: 5 – Future

12.4 Multiplayer

12.4.1 Description: The Virtual Reality Xplorer must allow multiple users to interact in the same environment in real-time.

12.4.2 Source: Team VR-X

12.4.3 Constraint: Networking falls outside of the project scope due to time.

12.4.4 Standards: None

12.4.5 Priority: 5 - Future

12.5 Omni Treadmill Integration

12.5.1 Description: Team VR-X must integrate the Virtual Reality Xplorer to utilize the Omni Virtuix Treadmill as an input device.

12.5.2 Source: Team VR-X

12.5.3 Constraint: The Omni Virtuix Treadmill won't be released until 2014 and the cost exceeds our budget. Due to this we will not be able to integrate the Omni Virtuix Treadmill.

12.5.4 Standards: None

12.5.5 Priority: 5 – Future

12.6 Offered on Game Client

12.6.1 Description: The Virtual Reality Xplorer must be offered on a PC game client such as Steam or Origin.

12.6.2 Source: Team VR-X

12.6.3 Constraint: Marketing the Virtual Reality Xplorer falls out of the scope of the project.

12.6.4 Standards: None

12.6.5 Priority: 5 – Future

12.7 Cross-Platform Compatibility

12.7.1 Description: The Virtual Reality Xplorer must work with Windows and Mac OS.

12.7.2 Source: Team VR-X

12.7.3 Constraints: Team VR-X lacks knowledge in developing for Mac OS.

12.7.4 Standards: None

12.7.5 Priority: 5 – Future